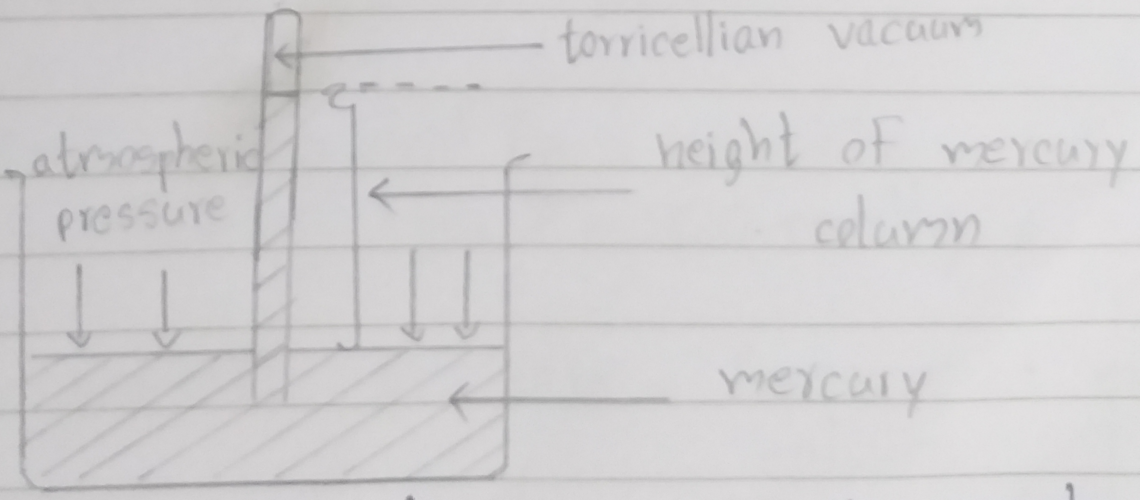
Chapter - 3
Pressure

3.1 Atmospheric Pressure

The pressure exerted on a body by the atmosphere, due to the weight of the atmosphere is called atmosphere pressure.

3.2. Barometer

Barometer is a device for measuring atmospheric pressure.



Simple mercury barometer

Eg 3.1 Find the force due to the atmosphere which is acting 3 m^2 area on the earth's surface. At the earth's surface, the magnitude of the atmospheric pressure is about 100 kN m^{-2}?

Area, $A = 3 m^2$, $p = 100 \text{ kN } m^{-2}$

$$p = \frac{F}{A}$$

The force acting due to the atmosphere, $F = pA = 100 \times 3 = 300 \text{kN}$

3.1 ~~Atmos~~

Density

Density is the ratio of mass to volume of a substance.

In symbols,

$$\rho = \frac{m}{V}$$, where

ρ = density
m = mass
V = volume

The standard atmospheric pressure is expressed in various units

1 atm = 1.013×10^5 Pa = 1013 hPa = 1.01 bar
= 14.7 lb in^{-2} (psi) = 760 mmHg = 760 torr

Atmospheric pressure = Pressure of mercury column

$$p = \rho g h$$

(1) If the height of mercury column = h column

(2) The cross-sectional area = A

(3) The volume of the mercury column = V

$= A \times h$

$= Ah$

(4) The weight of the column,

$w = mg \quad (\rho = \frac{m}{V} \Rightarrow m = \rho V)$

$= \rho V g$

$= \rho A h g$

(5) Pressure exerted by ~~by~~ the atmosphere,

$p = \frac{F}{A} \quad (F = w)$

$p = \frac{w}{A}$

$= \frac{\rho A h g}{A}$

$p = \rho h g$

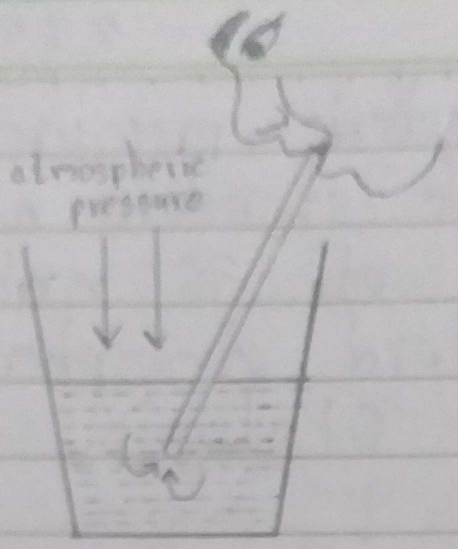
$p = \rho g h$

The normal atmospheric pressure at sea level is the standard atmospheric pressure. A pressure of 760 mmHg is known as standard atmospheric pressure (or) 1 atmosphere (1 atm).

Some Applications of the Atmospheric Pressure in Daily Life

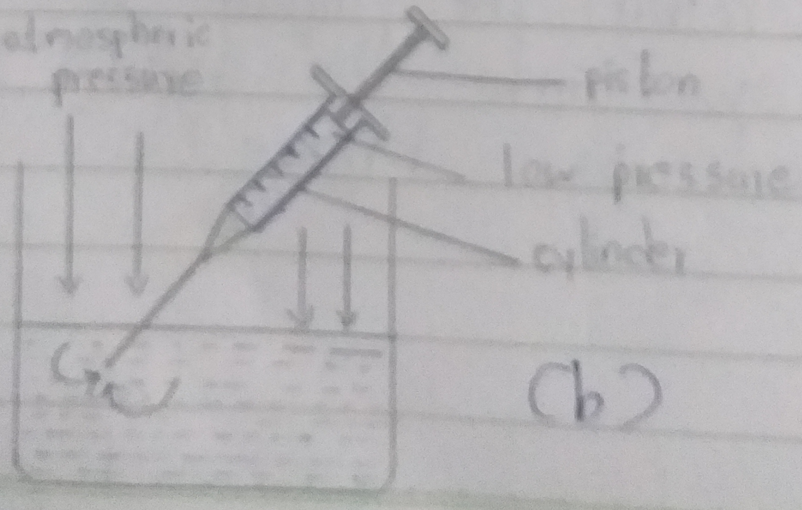
(1) Sucking liquid by a drinking straw

The action of sucking increases the volume of the lungs, thereby reducing the air pressure in the lungs and the mouth. The atmospheric pressure acting on the surface of the liquid will then be greater than the pressure in the mouth, thus forcing the liquid to rise up the straw into the mouth. It is illustrated in Figure (a).



(a)

(2) Drawing a liquid into a syringe
When the piston is pulled up, the pressure inside the cylinder decreases. Atmospheric pressure acting on the liquid drives the liquid into the cylinder through the nozzle | as shown in Figure (b)

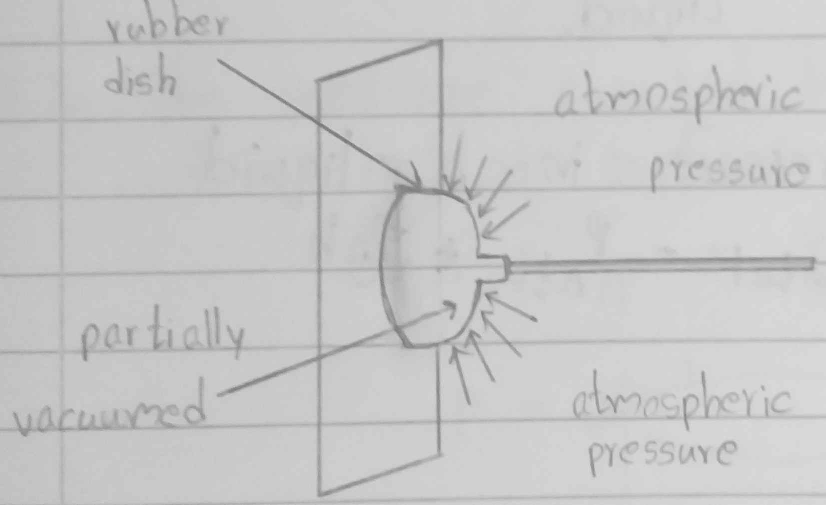


(b)

Date 2. 8. 23 Page 7

(3) Pressing rubber sucker on a flat smooth surface.

When pressing on a smooth surface, most of the air inside the rubber sucker is squeezed out and the pressure is reduced. The sucker is held in position by the atmospheric pressure on its outside surface as shown in Figure (c)



(c)

Eg 3.2 Express 2 atm pressure in mmHg and bars.

1 atm = 760 mmHg, 2 atm = 2 × 760 mmHg
= 1520 mmHg

1 atm = 1.01 bar, 2 atm = 2 × 1.01 bar
= 2.02 bar

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3.3. Pressure in a Liquid.

Calculate the pressure in a liquid.
Show that $P_{total} = P_{atm} + \rho g h$

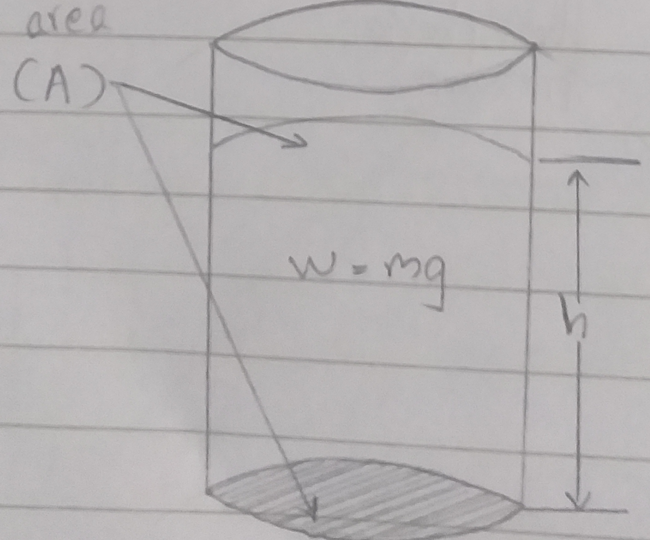

Figure. Liquid in a cylindrical container

Date 4. 8. 23 Page

(1)- Let us fill a cylindrical container having bottom surface area A with a liquid of density ρ up to a height h.

(2)- The volume of liquid in container is $V = Ah$.

(3)- The mass of liquid $m = \rho V = \rho A h$.

(4)- The weight of the liquid will be

$$w = mg = \rho g A h.$$

(5)- The pressure exerted by the liquid at the botton surface is

$$P = \frac{F}{A} = \frac{w}{A} = \frac{\rho g h A}{A}$$

$$P = \rho g h$$

(6)- Therefore, the true pressure at the depth h in the liquid,

$$P_{total} = P_{atm} + \rho g h$$